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No. XVI.

ON THE PRINCIPAL CAUSE OF THE ROCKING
MOTION OF LOCOMOTIVE ENGINES AND
CARRIAGES, AND OTHER MACHINERY.

BY GEORGE HEATON, of Birmingham.

January 31st, 1844.

THOMAS HOBLYN, ESQ. F.R.S. V.P. IN THE CHAIR.

Abstract.

"My particular attention," observes the author, "was accidentally called to this subject in the spring of 1838, while employed in the inspection of a steam-engine and machinery used for making "use iron," boiler plates, and rolled bars.

Several years prior to the time in question the steam-engine had had a larger steam cylinder put to it than the one it originally possessed, and the two fly-wheels had been rehung and made to revolve more truly on the edges than previously. These fly-wheels when running quickly had, for a considerable period, made a rumbling noise; the light one, or quick wheel, would sometimes jump as high as the gland or bearings would allow it, and appeared to spring the sills to which it was fastened, so much so as to cause the whole building to be shaken. The large wheel had no gland upon its neck, it having been considered useless when the works were erected. To lift this end of the shaft, with its fly-wheel, spur-wheels, and cam-rings, it required six times as much force as the engine was able to exert simply in pulling; but, nevertheless, from its momentum, the larger wheel frequently jumped two or three inches high from its bearings, and fell down again with a tremendous blow.

Several engineers and millwrights had been consulted on the subject, the millwrights affirming that it must be

the engine, which, by pulling irregularly, caused the jumping motion; the engineers, on the contrary, that it must be in the machinery of the forge, for the engine seemed to act very regularly. The large fly-wheel had a spur-wheel of about 9 feet diameter, with 84 teeth, 11 inches wide on the face, and $4\frac{1}{8}$ inches pitch, and the crank pin, for the connecting rod of the engine, was fixed in one of its arms. The spur-wheel, worked into a nut or pinion of 25 teeth, fixed upon the smaller fly-wheel shaft, it being what is called rising gear, the friction upon some of the teeth was so considerable as to remove from them every particle of grease immediately it was put on, and as soon as the teeth were dry it made them appear as if they had been left from a coarse file: the sparks of fire produced by the friction were frequently seen to fly up at least 2 feet.

Although there were 25 teeth, or what is called a hunting tooth, in the nut, the principal wear and tear occurred upon four of the teeth on one side, and 5 on the opposite side, leaving the hard skin from the casting upon many of the other teeth of the pinion, even when some of these 9 teeth had had nearly $\frac{3}{8}$ of an inch worn off them. This nut weighed about 11 cwt., and being in use both night and day, seldom lasted more than three months before the teeth were worn so thin and had so much play as to cause them to strike a sufficiently hard blow to break the teeth off the large wheel.

I examined the steam-engine and considered it to be in fair working order, and that the fault lay in the fly-wheels, they being heavier on one side than on the other, thus causing their jumping motion. On hearing this opinion the proprietors of the mill were much astonished, and one of them immediately asked me if I thought it

possible "that those wheels, having, together with their shafts, the respective weights of 12 and 20 tons, could be so heavy-sided as to jump up and down 2 to 3 inches at a time, and that from 40 to 60 times in a minute, without such motion being distinctly perceptible." My answer was in the affirmative, and I cited various instances in which smaller machinery was subject, in the same manner, to irregularities and deficiencies of action, simply from want of equipoise.

It was agreed that, from the simplicity of my suggestion, it should be tried; the wheels were accordingly thrown out of gear, so that it could be ascertained experimentally how much it required to set each wheel in motion, in each direction, separately.

The smaller fly-wheel, which was 16 feet in diameter, required 160lbs. more on one side than on the opposite to set it in motion. A piece of iron, weighing 160lbs., was accordingly fixed inside the ring of the wheel, which made about 70 revolutions per minute. When the large fly-wheel (which was 18 feet in diameter) was examined, *it was found to require 322 lbs. more on one side than the other to set it in motion.* The 322 lbs. weight was accordingly fixed inside its periphery.

The wheels having been thus altered, the forge was set to work; the wheels ran steadily and pleasantly, the grease kept upon the teeth, the nut was not more worn at the end of four years and two months work than some of the teeth had been with only three months' use, and the works ran altogether so quietly that you may now pass close to the walls of the premises and scarcely hear that there is any machinery in motion, whereas before they were balanced the noise was frequently heard at the distance of a mile and a half. The proprietors assure me

that their present repairs are as nothing to what they were formerly, and they can now do much *more work* with the engine than before the wheels were balanced.

From the consideration of the foregoing circumstances, I had not the least doubt but that the twisting and rocking motions of railway-engines were caused by the crank and gearing at the moment of their reversing their centres ; and I determined to test the matter in the modes I shall at once explain."

Mr. Heaton then proceeded to exhibit experimentally to the Society some of the causes of oscillation in railway-carriages, incidental to the want of equilibrium in their various revolving parts, such as the wheels, axles, cranks, &c. These sources of error were made manifest by means of five different models, so constructed as to be capable of being put either in or out of equilibrium at pleasure, by the attachment or removal of small weights. The several models were put in rapid motion by the descent of a weight, by the action of a train of wheels, as in the common roasting-jack, and by other modes. When the whole of the parts of the models that were in motion were strictly in equilibrium, they performed their various revolutions in a quiescent manner, whereas, on the contrary, when the equilibrium of the masses was disturbed by the annexation of the small weights, the models received various disturbing motions illustrative of the jumping, rocking, and twisting movements or disturbances to which railway-engines and carriages are occasionally subject. It was also shewn that the irregular motion caused wasteful expenditure of the primary power, as the motions uniformly endured longer when the models were in accurate equipoise.

The several results were made abundantly manifest

both to the eyes and ears of the auditory ; but without the aid of diagrams and explanations, beyond the limit of this report of the proceedings of the evening, justice could not be rendered to the truthfulness of the experiments, the several results of which are recorded in a tabular form. The whole went to prove most satisfactorily, that whether machinery be large or small, the want of strict equilibrium in the parts subject to rapid circulation is a source of paramount mischief, and that in railway travelling the want of true equipoise elicits many of the inconveniences felt in this important method of locomotion.*

No. XVII.

ON THE PATENT CANNABIC COMPOSITION.

By B. ALBANO, C.E.

Feb. 7, 1844.

W. TOOKE, ESQ. F.R.S. HON. V.P. IN THE CHAIR.

THE author of this communication having been applied to by the inventor, a native of Rome, to assist him in the mechanical part of the manufacture of this new composition, was so struck with the beauty of the invention that he became interested therein by taking out the English patent for the same.

Its chief ingredient is hemp, which, in connexion with several other materials, undergoes a chemical pro-

* The original paper and tables may be inspected in the Society's Library by those who desire to learn the exact nature of the models and of the experiments made therewith.